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## FINAL TECHNICAL REPORT

**TITLE:** Zero Electron Kinetic Energy/Velocity Map Imaging (ZEKE/VMI)  
Spectroscopy of Negative Ions

**PRINCIPAL INVESTIGATOR:** Daniel M. Neumark

**DATE:** 05/01/03 – 07/31/04

**GRANT NO:** F49620-03-0261 03-1-0261

**SENIOR RESEARCH PERSONNEL:** none, other than Principal Investigator

**JUNIOR RESEARCH PERSONNEL:** Art Bragg, AnnElise Faulhaber, Michael Ferguson, Scott Goncher, Aster Kammrath, Katherine Kautzman, Jeong Hyun Kim, Giovanni Meloni, Matt Nee, Andreas Osterwalder, Darcy Peterka, Sean Sheehan, Niels Sveum, David Szpunar, Jan Verlet, Chia Wang, Jia Zhou

### Abstract:

Construction of the slow photoelectron velocity-map imaging (SEVI) instrument was completed and the first results were obtained, demonstrating the power of the technique in measuring high resolution ( $\sim 0.5$  meV) photodetachment spectra of negative ions. Work is continuing on improving the performance of this instrument, with particular focus on reducing stray magnetic fields in the detection region and modifying the ion source and mass spectrometer to achieve higher ion signal and stability.

### Final Technical Report:

The SEVI instrument was used to obtain high resolution photodetachment spectra of  $\Gamma$ ,  $\Gamma^-$  ( $\text{CO}_2$ ), and  $\text{Cl}\cdot\text{D}_2^-$ . The SEVI spectra of  $\Gamma$  and  $\Gamma^-$  ( $\text{CO}_2$ ) served as test systems, since these ions were studied earlier in our group using anion zero electron kinetic energy (ZEKE) spectroscopy. The SEVI spectra were of comparable resolution but data acquisition times were improved by about a factor of 100. The  $\text{Cl}\cdot\text{D}_2^-$  SEVI spectrum showed partially resolved structure corresponding to a progression in the hindered rotor levels of the  $\text{Cl}\cdot\text{D}_2$  van der Waals complex, a result of considerable interest in fundamental reaction dynamics owing to the importance of this complex in the  $\text{Cl} + \text{D}_2$  reaction. Preliminary results on the SEVI spectrum of the methoxide anion ( $\text{CH}_3\text{O}^-$ ) show newly resolved structure owing to the interplay of spin-orbit and Jahn-Teller effects in the  $\text{CH}_3\text{O}$  radical that were not seen in conventional photoelectron spectra of this anion.

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## **Publications**

A. Osterwalder, M. J. Nee, J. Zhou and D. M. Neumark, "High resolution photodetachment spectroscopy of negative ions via slow photoelectron imaging," *J. Chem. Phys.* 121, 6317 (2004).

## **Interactions**

Gordon Research Conference, Oxford University  
Oxford, London  
September 18-25, 2003

New Frontiers in Chemical Dynamics and Femtochemistry  
The University of York, Department of Chemistry  
Heslington York YO10 5DD  
October 25 – 30, 2003  
XIVth Symposium on Atomic, Cluster and Surface Physics  
La Thuile  
Aosta, Italy  
January 2 – 6, 2004

227<sup>th</sup> ACS National Meeting  
Anaheim, CA  
March 28 – April 1, 2004

AFOSR Molecular Dynamics Contractors' Meeting  
New Port, Rhode Island  
May 24 –26, 2004

DICP Symposium on Molecular Dynamics  
Dalian, Liaoning  
P. R. China  
July 21-23, 2004